Active Project (2016 - 2016)

High Energy Density Li-ion Batteries Enabled By a New Class of Cathode Materials, Phase I Project

SBIR/STTR Programs | Space Technology Mission Directorate (STMD)

ABSTRACT

The proposed program addresses NASA's need for advanced battery technologies, and in particular the energy storage needs for Extravehicular Activities. The most advanced commercially available Li-ion batteries use intercalation-based cathode materials, where the energy density is limited by the oxidation states of the metal oxide and the availability of lithium ions. In contrast, non-oxide cathode materials based on conversion mechanism offer an opportunity to realize exceptionally high capacity. Literature reports suggest that an energy density in excess of 1200 Wh/kg is possible at the material level. However, it has been a challenge to obtain such high performance at the cell level in practical batteries. Building upon NEI's experience in synthesis, surface modification and functionalization of nanoscale materials, the Phase I program aims to demonstrate the commercial feasibility of a new class of Li-ion batteries that utilizes a unique cathode architecture. In Phase I, materials will be synthesized and assembled into cells, and electrochemically tested under parameters of relevance to NASA's EVA application. Sample cathode materials will be submitted to NASA at the end of the Phase I program. In Phase II, 2Ah capacity Li-ion cells with cell-level specific energy and energy density of 500Wh/kg and 1000 Wh/l, respectively, will be fabricated and delivered to NASA.

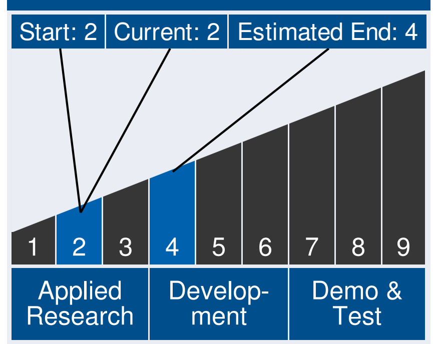
ANTICIPATED BENEFITS

To NASA funded missions:

Potential NASA Commercial Applications: A new class of rechargeable Li-ion batteries with an energy density greater than 450 Wh/kg (and volumetric density of at least 1000 Wh/L) with good zero degree performance is needed for use in the EVA spacesuit in future human missions. In addition to the energy density consideration, the battery needs to be safe for human operation, and have a calendar life in excess of 5 years. The cells should be sufficiently robust to withstand abuse, and not be

Table of Contents

Technology Maturity



Management Team

Program Executives:

- Joseph Grant
- Laguduva Kubendran

Program Manager:

- Carlos Torrez

Continued on following page.

susceptible to thermal runaway. The proposed program aims to demonstrate that a cathode material based on conversion mechanism can be engineered and assembled into a practical battery that meets NASA's requirements. In addition to addressing the EVA spacesuit battery requirements, the proposed technology has wider ramifications for other NASA needs (e.g., Human Lunar and Mars Landers and Rovers) where the energy density requirements are lower, but cycle life expectations are greater.

To the commercial space industry:

Potential Non-NASA Commercial Applications: Li-ion batteries are ubiquitous, having found use in portable devices, electric vehicles, stationary power storage, and myriad other applications. According to one estimate, Li-ion batteries account for more than 35% of the market for batteries, which is projected to be $120 billion by 2019. Virtually all Li-ion batteries use intercalated metal oxide materials as the cathode. This fundamentally limits the energy density of the material. The proposed program aims to advance the state of the art of conversion-based cathode materials so as to lead to a near doubling of the energy density from current levels.

Management Team *(cont.)*

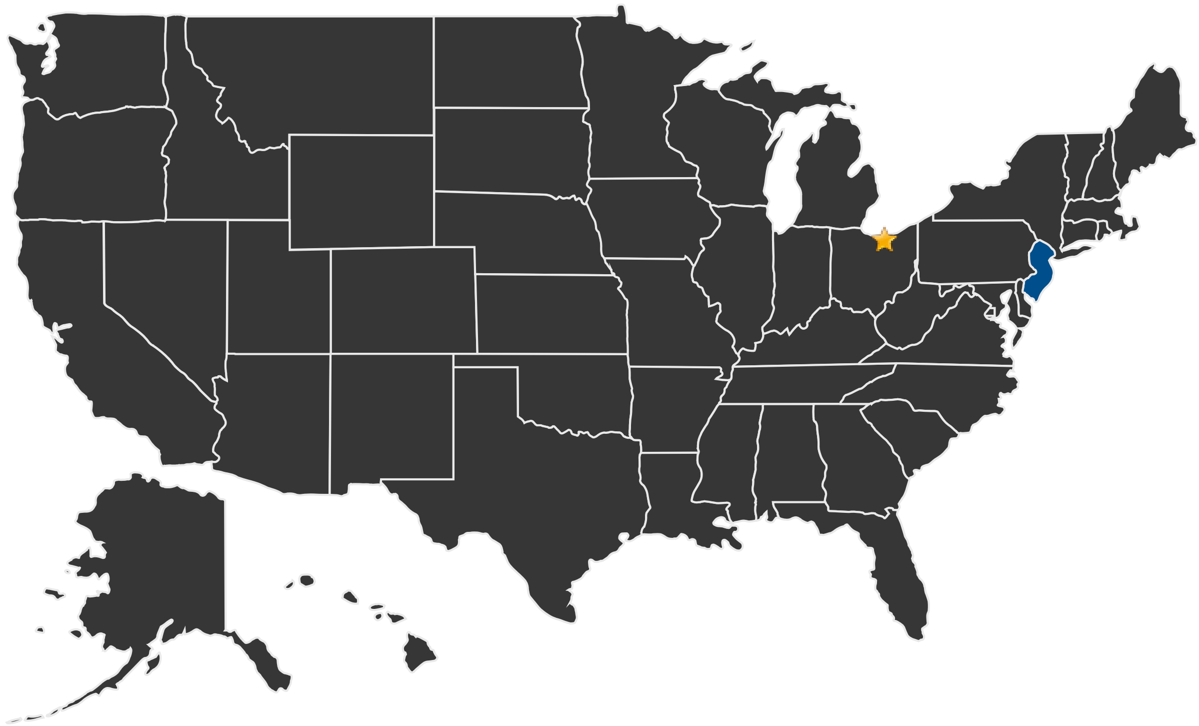
Principal Investigator:

- Nader Hagh

Technology Areas

Primary Technology Area:
Space Power and Energy Storage (TA 3)
└ Energy Storage (TA 3.2)
  └ Batteries (TA 3.2.1)

U.S. WORK LOCATIONS AND KEY PARTNERS



U.S. States With Work

Lead Center:
Glenn Research Center

Other Organizations Performing Work:

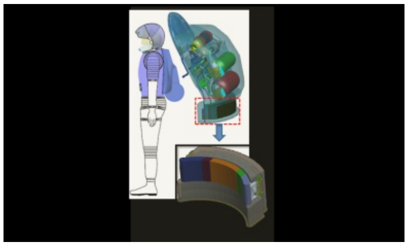
- NEI Corporation (Piscataway, NJ)

PROJECT LIBRARY

Presentations

- Briefing Chart
    - (http://techport.nasa.gov:80/file/23166)

IMAGE GALLERY



High Energy Density Li-ion Batteries Enabled By a New Class of Cathode Materials, Phase I

DETAILS FOR TECHNOLOGY 1

Technology Title

High Energy Density Li-ion Batteries Enabled By a New Class of Cathode Materials, Phase I

Potential Applications

A new class of rechargeable Li-ion batteries with an energy density greater than 450 Wh/kg (and volumetric density of at least 1000 Wh/L) with good zero degree performance is needed for use in the EVA spacesuit in future human missions. In addition to the energy density consideration, the battery needs to be safe for human operation, and have a calendar life in excess of 5 years. The cells should be sufficiently robust to withstand abuse, and not be susceptible to thermal runaway. The proposed program aims to demonstrate that a cathode material based on conversion mechanism can be engineered and assembled into a practical battery that meets NASA's requirements. In addition to addressing the EVA spacesuit battery requirements, the proposed technology has wider ramifications for other NASA needs (e.g., Human Lunar and Mars Landers and Rovers) where the energy density requirements are lower, but cycle life expectations are greater.